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ABSTRACT

Investigated were the effects of increased time allotments, and of the teacher's preference for a particular time allotment, on fourth grade students' achievement in and attitudes to science. The sample involved 324 students from 16 classrooms. Students were randomly assigned to classes, and teachers to the control (minimum time, averaging 20 minutes per day) and experimental (increased time, averaging 35 minutes per day) conditions. Teacher time preferences were determined from a questionnaire. Students were pre- and posttested on science achievement using the Cooperative Sequential Tests of Educational Progress, Science, Form 4A, and an experimenter developed test on the science content taught. Pre- and posttest measures of attitudes were obtained from interviews using Lowery's Projective Test of Attitudes. During the school year all groups gained in science achievement. Changes in attitudes toward science occurred in both directions. No differences significant at the 0.01 level were found attributable to either time allotment or teacher preference for time allotment. No significant interactions were found between students' reading level or I.Q. and time allotment. [Not available in hardcopy due to marginal legibility of original document.] (EB)

THE EFFECTS OF AN INCREASED TIME ALLOTMENT ON STUDENT ATTITUDES AND ACHIEVEMENT IN SCIENCE

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Introduction

In recent years science education has received increased attention. Much of this attention has focused on how students learn, the structure of knowledge, teaching methodology, and the materials for instruction. As a result of this increased attention, new programs have been proposed and developed. Older programs have been updated or discarded.

At the same time other influences have been affecting the overall school curriculum. State legislatures have been mandating new education programs. Special interest groups have been recommending programs for inclusion in the school curriculum. For years people interested in science education have been requesting more time for science instruction during the school year.

Two other forces have been paralleling these influences. There has been an increase in student population. New schools are being built every day. There has been an overall increase in the taxes levied on the local taxpayer by the state and local school district to finance education. With this increase in the financial support for education has come the request for the local school to justify its financial needs. Taxpayers are now asking for a cost accounting of

educational expenses.

At the center of this attention is the individual school district that has only a given number of hours in a school day or instructional year. As a result of requests for more instructional time, legislative curriculum mandates, increased student enrollment, and the cost accounting requested by the taxpayer, teachers are being asked to justify their expenditures. One of these expenditures is time. Will additional instructional time devoted to a given subject area result in an increase in achievement on the part of the learner? Will additional time devoted to science instruction result in an increase in student achievement in science?

In the past, schools have allotted time for science instruction. This time allotment has been based on the opinions of educators or on administrative expediency rather than on educational research findings. When requesting increased time for science instruction, people interested in science education have given several reasons for their requests: 1) the need for a knowledge of science in later life; 2) the need for knowledge of natural phenomena for a deeper appreciation of one's natural surroundings; 3) the necessity of an understanding of the methods of science for evaluation of the findings of science; 4) the need for experience in the processes of science to discern between opinion and evidence in the decision making process in areas other than science; 5) science is by its nature difficult to learn and is therefore excellent training for the academically oriented student; 6) children have little experience in the understanding of natural phenomena, and it is the responsibility of the school to provide such

experience.

Most of these reasons are related to assumptions about how children learn. The first involves consideration of lateral transfer of learning. These educators assume that by permitting the child to experience the development of a concept or principle in several non-identical situations, the child will be able to analyze a new situation involving like elements, recognize the relationships, and apply or express the principle. A second assumption involves vertical transfer of learning. Most educators assume that broad generalizations or principles, involving relationships at a higher order of complexity, can be more easily developed when the underlying principles and concepts have been thoroughly understood. They feel that concept learning is subverted when the teacher tries to push the development of a generalization or principle by a single demonstration or single experience as a strategy of instruction. Future learning is therefore more difficult for the student.

Problem

To assist educators in making reasonable decisions concerning science time allotments, this study (2) attempted:

1. to investigate whether an increased time allotment increases student achievement in science;
2. to determine whether the teacher's preference for a particular science time allotment affects student achievement in science.

An additional consideration was made as a part of this study. Attitudinal outcomes of instruction are frequently mentioned in statements of objectives of curricular offerings. Klopfer (4) feels

that science education should concern itself with the fostering of "wholesome attitudes toward science, scientific endeavor, and scientists" as an objective of instruction. He states, "It may not be too strong to say that this is an area where the greatest long-term significance of all our science teaching lies. The extent of our success is in instilling favorable attitudes in our students, much more than any science subject matter may learn and probably forget, will largely determine whether or not they will give their support to the scientific enterprise as adult citizens of the future." Gallagher and Korth (3) say the same thing a little differently, "Since attitudes are learned enduring predispositions to behavior, student attitudes toward science may be reflective of their school experiences in science classes, and may also influence future actions such as career choice and willingness to be supportive of science."

With these considerations in mind, any attempt to increase student achievement in science should examine the possible change in the students' attitudes toward science as a result of the change in instructional time allotment. This study, therefore, attempted to answer some questions that pertain to student attitudes toward science:

1. Will an increased time allotment affect student attitudes toward science?
2. Will the teacher's preference for a particular science time allotment have an effect on student attitudes toward science?

Procedures and Materials

The study was conducted in the Alameda Unified School District, Alameda, California, during the 1968-69 school year. Sixteen fourth-grade classrooms (324 students: 169 girls and 155 boys) in eight different schools were involved in the study.

Alameda Unified School District practices heterogeneous grouping of students in the elementary grades. Students could, therefore, be randomly assigned to individual classes within each school. All fourth-grade teachers in these schools were willing to participate in the project, and two teachers in each school were randomly selected and assigned to teach the control and experimental classes.

Time Allotments. Based upon an informal survey of fourth-grade science time allotment practices of several school districts in the area conducted by the investigator, teachers were assigned to one of two time allotments for science instruction: Control group (to average approximately 20 minutes per day) and Experimental group (to average approximately 35 minutes per day).

Most districts in the area do not mandate the actual number of minutes that must be devoted to specific areas of the curriculum each day. Most recommend the number of minutes per week that should be devoted to curriculum areas. Teachers are generally permitted to exercise their professional judgement in their distribution of instructional time allotments on any given day. In this manner, teachers are permitted to meet the needs of their respective classes and capitalize on a flexible teaching format.

Verification of science instruction was accomplished by using a

Time Log developed by the author for data retrieval and informational feedback to the teachers. To verify that the entries made on the time logs were being reported accurately, the investigator made random visits to each teacher's classroom during the entire data gathering period. During these visits, the investigator also examined the time logs to see that the entries thereon were being made on a regular basis and were in agreement with the observations made during the visit.

The Curriculum. Teachers were requested to complete the basic curriculum, Concepts in Science, 4 (1), adopted by the State of California and to refrain from gross departures from it. Although incidental science arising from student and teacher interaction and interest could and did arise, the number of students and the number of teachers involved in the study were considered to be large enough to reduce such occurrences to a random effect, having little effect on the overall outcomes of instruction.

Teacher Questionnaire. Information concerning teacher background and science time allotment preference was obtained by using a questionnaire constructed by the author. Based on consistent responses, four teacher preference and assignment groups could be obtained from this information: Preferred Minimum -- Assigned Minimum; Preferred Minimum -- Assigned Increased; Preferred Increased -- Assigned Minimum; Preferred Increased -- Assigned Increased.

Test Data. To establish pre-experimental groupings, measures of I.Q. and reading were obtained from the cumulative files for each student.

Pre-experimental measures of general science knowledge were obtained

by using the Cooperative Sequential Tests of Educational Progress, Science, Form 4A (STEP).

Pre-experimental measures of fourth-grade science knowledge were obtained by using the author's Science Achievement Test (SAT). This test consisted of 50 multiple choice questions based on the fourth-grade science curriculum as adopted by the State of California. The reliability and validity of the SAT were established on a pilot study.

Pre-experimental measures of attitudes toward science were obtained through individual interviews using Lowery's (5) Projective Tests of Attitudes (PTOA). All pre-tests were administered during the first two weeks of school.

Post-experimental measures were obtained by repeating the same tests in the same form. All post-tests were administered during the last two weeks of school.

Statistical Tests and Decision Rule. The statistical tests used in the study were the F-test and the Kruskal-Wallis H-test. The data from all criterion measures were organized and processed on an IBM 6400 computer.

The BMD 08V program (nested design) was employed in the F-test calculations, and the ARIEL program was used in the H-test calculations. The BMD 08V program requires equal cell sizes. Therefore, some data were lost by randomly casting out some observations to reduce some cell sizes. This loss of data was not considered to be significant in view of the total sample size.

The decision rule established for the analysis was to reject the null hypothesis whenever the probability of committing a Type I error

was equal to or less than .01.

Results

Experimental and control group teachers differed only slightly. Control group teachers were about 1 year older, had taught 4 years longer, and had 2.5 years more teaching experience at the fourth-grade level. Experimental group teachers had a wider range of undergraduate majors but had not taken as many semester units beyond their college degrees. Experimental group teachers had taken more semester units of college level science (including science methods courses), but the recency of college level science instruction (including science methods courses) was the same as the control group teachers.

As a result of random assignment and consistent responses to items on the teacher's questionnaire, the four anticipated time allotment preference and assignment groups were obtained.

The eight experimental group teachers reported a mean of 35 minutes of science instruction per day, and the eight control group teachers reported a mean of 20 minutes of science instruction per day.

Pre-test

Teacher Time Allotment Preference and Assignment Groups. Analysis of the mean rank scores of the four teacher preference and assignment groups or all of the pre-test criterion measures revealed no significant differences at the beginning of the study.

Experimental vs Control. Similarities in knowledge of general science between groups within schools were established through the use of the STEP test. Although significant differences were found between schools, no significant differences were detected between

groups within schools.

Similarities in knowledge of fourth-grade science between groups within schools were established by using the SAT test, Although significant differences between schools were observed, only 1 significant difference was detected between groups within schools. This difference was attributed to random effects.

Similarities in attitudes toward science between groups were established by using the PTOA. Again, significant differences were detected between schools, but no significant differences were detected between groups within schools.

Boys vs Girls. Only 1 significant difference was found between boys and girls within schools on any of the pre-post criterion measures. Analysis revealed no significant interactions on the STEP, SAT, or PTOA.

Above Median vs Below Median Reading Groups. The above median reading group mean scores were significantly higher on the STEP test within all schools. The above median reading groups within 2 schools scored significantly higher on the SAT. Only 1 such significant difference was detected on the PTOA. Analysis revealed no significant interactions on the STEP, SAT, or PTOA.

Above Median vs Below Median I.Q. Groups. The above median I.Q. group scored significantly higher on the STEP test within 6 of the 8 schools. The above median group also scored significantly higher within 3 schools on the SAT. Only 2 such significant differences were found on the PTOA. Analysis revealed no significant interactions on the STEP, SAT, or PTOA.

Post-test

Teacher Preference and Assignment Groups. Examination of the mean rank scores for the four teacher time allotment preference and assignment groups revealed no significant differences on the STEP, SAT, or PTOA post-tests. No significant differences between groups were found on the STEP, SAT, or PTOA mean gain rank scores.

Experimental vs Control. Inspection of the mean scores revealed that all groups gained in knowledge of general science as measured by STEP and gained in knowledge of fourth-grade science as measured by the SAT. Examination of the PTOA mean scores revealed that changes in attitudes toward science had occurred in both directions (positive and negative).

Although significant differences still existed between schools on the STEP, SAT, and PTOA post-test scores, only 1 significant difference between groups within schools was detected. Additionally, 1 significant difference was found on the mean gain scores comparison. These differences were attributed to random effects.

Boys vs Girls. Although significant differences still existed between schools on the STEP, SAT, and PTOA post-tests, no significant differences between boys and girls within schools existed. Additionally, analysis revealed only 1 significant interaction (treatment by sex within schools) on the PTOA in one school. On the basis of non-significant interactions, there was no reason to attribute differential effects to the treatment variable.

Above Median vs Below Median Reading Groups. Examination of the post-test mean scores revealed that the above median reading groups scored significantly higher than the below median reading groups within schools on the STEP and SAT in 7 schools. No significant differences within schools were detected on the PTOA. Inspection of the mean gain scores between groups within schools revealed only 1 significant difference. Further examination of the means of the reading groups between experimental and control groups within schools revealed no significant interactions (treatment by reading within schools) on the STEP, SAT, or PTOA. On the basis of non-significant interactions, there was no reason to attribute differential effects to the treatment variable.

Above Median vs Below Median I.Q. Groups. Examination of the STEP and SAT post-test mean scores revealed that above median I.Q. groups scored significantly higher on the STEP and SAT in 7 of the 8 schools. No significant differences were found to exist on the PTOA. Analysis of mean scores revealed no significant interactions (treatment by I.Q. within schools) on the STEP, SAT, or PTOA.

Conclusions

From this study one can say that increasing the time allotment for fourth-grade science instruction from a mean of 20 minutes per day to a mean of 35 minutes per day does not produce significant differences in student achievement in general science as measured by STEP or significant differences in student achievement in fourth-grade science as measured by SAT. Student achievement in science

increased while studying in both time allotment groups, but not differentially.

The teacher's preference for a particular science instruction time allotment produced no differential effects in student achievement as measured by STEP and SAT. Student achievement in science improved irrespective of the teacher's preference for and assignment to either the minimum or increased time allotment for science instruction.

From this study one can also say that increasing the time allotment for fourth-grade science instruction from an average of 20 to 35 minutes per day does not produce significant differences in students' attitudes toward science as measured by PTOA. Additionally, the teacher's preference for a particular time allotment produced no differential effects on students' attitudes toward science.

Certainly some other variable(s) had a greater effect on student acheivement. Recalling the assumptions underlying the requests for an increased time allotment assists in identifying potentially influential variables. Lateral transfer was assumed to be accomplished by permitting the child to experience the development of a concept or principle in several, non-identical situations. This manifold development would then permit the child to analyze a new situation involving like elements, recognize the relationships, and apply or express the concept or principle. Vertical transfer was assumed to be more easily accomplished when underlying concepts and principles are more thoroughly understood, permitting the development of broad generalizations and principles at higher levels of complexity.

Increased student achievement was registered by both groups in the study. This indicates that both groups experienced the development of concepts and principles in several situations, and these experiences included the necessary subordinate prerequisites for higher level understandings.

At least four alternatives could be used in an attempt to explain the findings of this study: 1) the experiences provided by all of the minimum time allotment group teachers were superior, though fewer in number, to those provided by the increased time allotment group teacher; 2) the classroom experiences of both groups were essentially the same in number and type, but the additional time spent by all of the increased time allotment group teachers was wasted in poor organization and presentation of experiences; 3) the times reported by both groups were not indicative of the total number and types of science concept development experiences to which the students were exposed, and incidental learning outside the formal classroom time devoted to science instruction accounted for the greatest number of experiences for the minimum time allotment group and/or both groups; 4) the experiences provided by both the experimental and control group teachers were sufficient in number and type to permit both lateral and vertical transfer to occur (as measured by STEP and SAT), but the effects of the additional experiences provided by the increased time allotment group teachers were not detected because of the limitations of the test instruments.

The design of the study and the number of teachers and students

randomly assigned to groups within schools do not permit this investigator to accept the first two explanations as plausible. Probability considerations dictate that it is unlikely that such occurrences could have taken place. Future efforts by curriculum developers should involve attempts: 1) to identify the number and kind of experiences necessary for students to accomplish the transfer tasks intended; 2) to determine the effects of experiences which occur outside of the time allotted to formal instruction in science; 3) to develop evaluation instruments which examine other levels of achievement other than that at the knowledge level and instruments that evaluate processes as well.

Most educators accept as a foregone conclusion that teachers exhibit (either intentionally or unintentionally) their attitudes toward a particular field of study while engaged in the act of teaching. They also assume that these attitudes are passed on to the student during the course of instruction, thereby changing the students' attitudes.

In this study the teacher's preference for a particular time allotment was examined as one way of grouping teachers with similar attitudes toward science. A preference for an increased time allotment was thought to be indicative of a positive orientation toward the field of science while a preference for a minimum time allotment was thought to be an indication of a less positive to negative orientation.

By comparing the achievement and attitudes of students across the four teacher preference and assignment groups, the findings indicate

that the teachers' preferences had no effect on student achievement or attitudes toward science.

It is now interesting to speculate as to how well the time allotment preferences reflect the teachers' attitudes toward science. For example, the teacher may feel that she does an effective job of teaching science because she likes science and can therefore reduce the time allotment for science instruction. In contrast to this, another teacher may feel she does a poor job of teaching science because she does not like science and therefore registers a preference for an increased time allotment to compensate for her feelings.

Since there was no significant shift (positive or negative) in student attitudes toward science, a broader area of investigation is suggested. Future researchers should attempt to determine how influential the teachers' attitudes are in changing the attitudes of their students.

Recommendations for Future Studies

This investigation was only an initial step that was taken in an attempt to examine the variable of time in science instruction. A study should be undertaken to determine the minimum amount of time necessary to produce the same level of student achievement in science as was observed in the two time allotments employed in this investigation.

In a different direction, the measuring devices employed in this study (specifically the STEP and SAT) examined only the knowledge level aspects of science. A study should be undertaken to ascertain the

effects of the time allotment variable on student acquisition of the processes of science.

This study also permitted the teachers to exercise their professional judgement as to how the time allotment would be distributed during the instructional day. Some teachers provided for science instruction on a daily basis while others taught science only two or three times per week, but for longer time intervals. A study should be undertaken to examine the effect of the blocking patterns employed by the teachers.

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